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Utilizing Creatinine Kinetics to Better Understand Instantaneous Creatinine Clearance

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Disclaimers

- The views expressed are the authors and do not reflect the official view or policy of the Department of Defense or its Components. A waiver was obtained for informed consent of the subjects used in this research as required by 32 CFR 219 and DODI 3216.02_AFI 40-402

Acute Kidney Injury

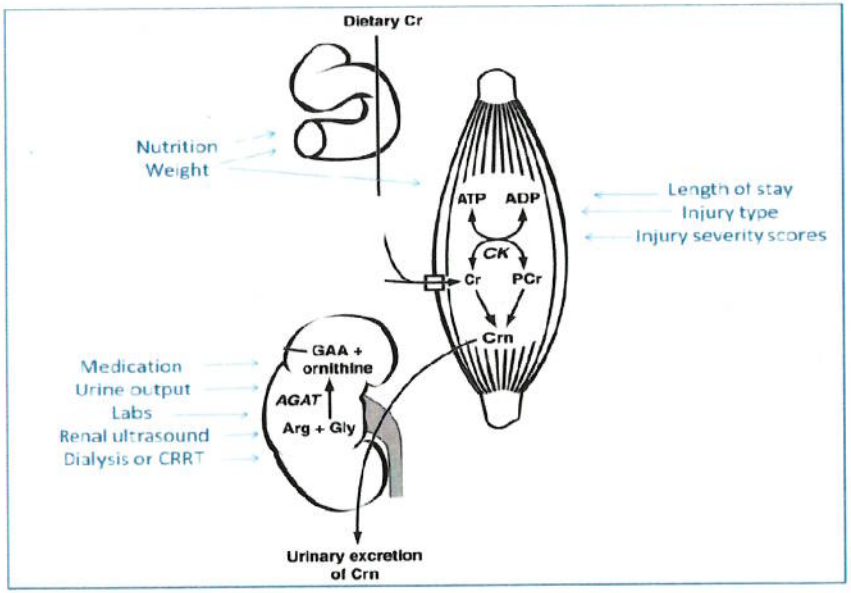
- In military combat causalities, AKI develops 34.3% of the time and is associated with 21.7% mortality
- Standard definitions of AKI use either the absolute value or the change in creatinine or urine output (THE PATIENT STATE)
- Nephrologists often look for the underlying cause (THE EVENT) and whether the damage is ongoing

AKIN Criteria

Classification/Staging System for AKIN Criteria	Definitions
AKIN 1	-Urine Output: < 0.5 ml/kg per hour for 6 hours -Serum Creatinine: Increase in SC > 0.3 mg/dl in 48hours -Serum Creatinine: Increase in SC from baseline > 150%
AKIN 2	-Urine Output: < 0.5 ml/kg per hour for 12 hours -Serum Creatinine: Increase in SC from baseline > 200%
AKIN 3	-Urine Output: < 0.3 ml/kg per hour for 24 hours, or anuria for 12 hours -Serum Creatinine: value being equal or greater than 4.0 mg/dl with an acute increase of at least 0.5mg/dl -Serum Creatinine: Increase in SC from baseline > 300%

The Real Question

- Is the patient getting better, worse or staying the same?
- Production of creatinine takes time
- The *changes* in renal function are seen more in the *changes* of serum creatinine as compared to production rather than the current absolute value
- For example, a patient with a creatinine of 1 mg/dl and instantaneous removal of all kidney function would still result in a creatinine of approximately 1 mg/dl a few minutes later


Dietary Cr
Nutrition
Weight
ATP
ADP
CK
Cr
PCr
Crn
Length of stay
Injury type
Injury severity scores
Medication
Urine output
Labs
Renal ultrasound
Dialysis or CRRT
GAA + ornithine
AGAT
Arg + Gly
Urinary excretion of Crn

Kinetic Estimate GFR (keGFR)

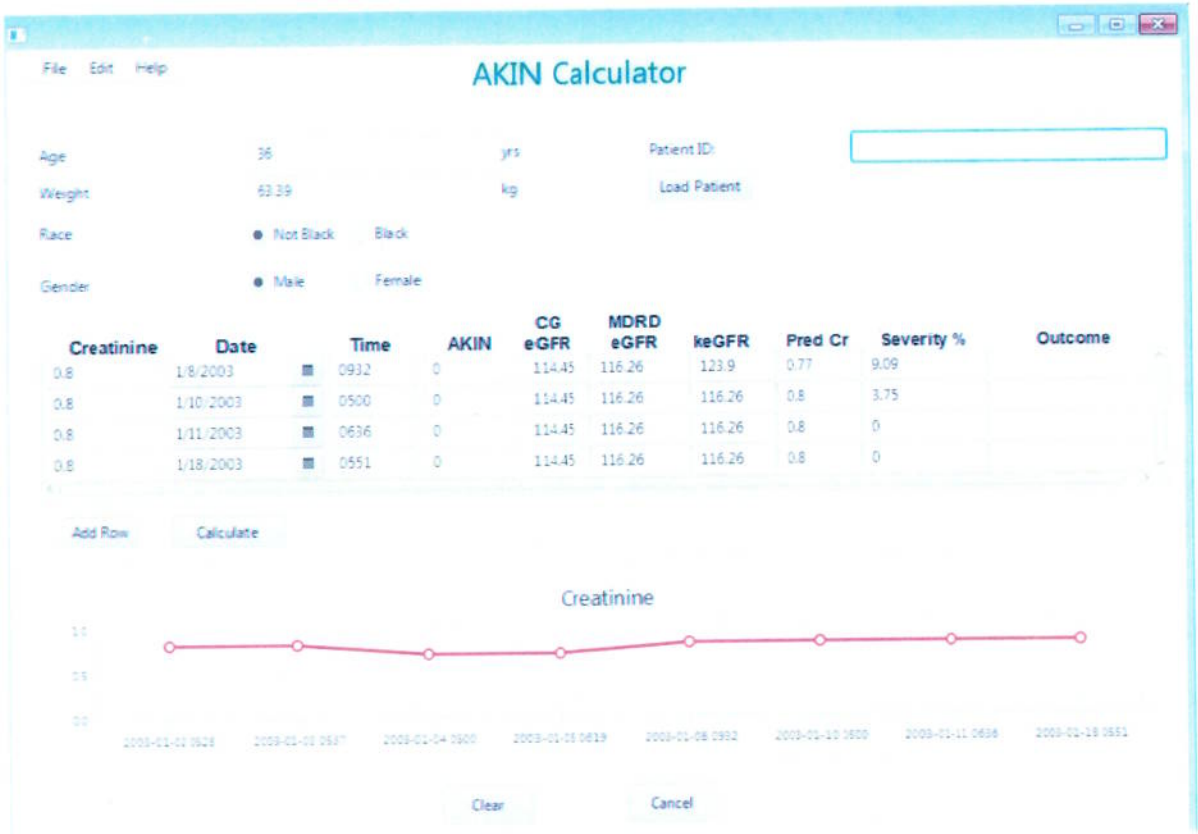
$$KeGFR = \frac{SSPcr\ x\ CrCl}{MeanPcr}\ x\ \left(1 - \frac{24\ x\ \Delta PCr}{\Delta Time(h)\ x\ Max\Delta\ PCr/Day}\right)$$

Stable Patients CrCl : MDRD, CKD Epi

Predicted Peak Creatinine

- We re-worked the keGFR equation to help us answer whether the patient was getting better, worse or staying the same
- At any time with 2 creatinines, we can predict the third and determine whether it is higher, lower or the same as predicted

$$Predicted\ Peak\ Creatinine = \frac{Max\Delta\ PCr/Day \times \Delta Time \times MeanPCr}{Max\Delta\ PCr/Day \times \Delta Time - 24 \times \Delta PCr}$$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kg
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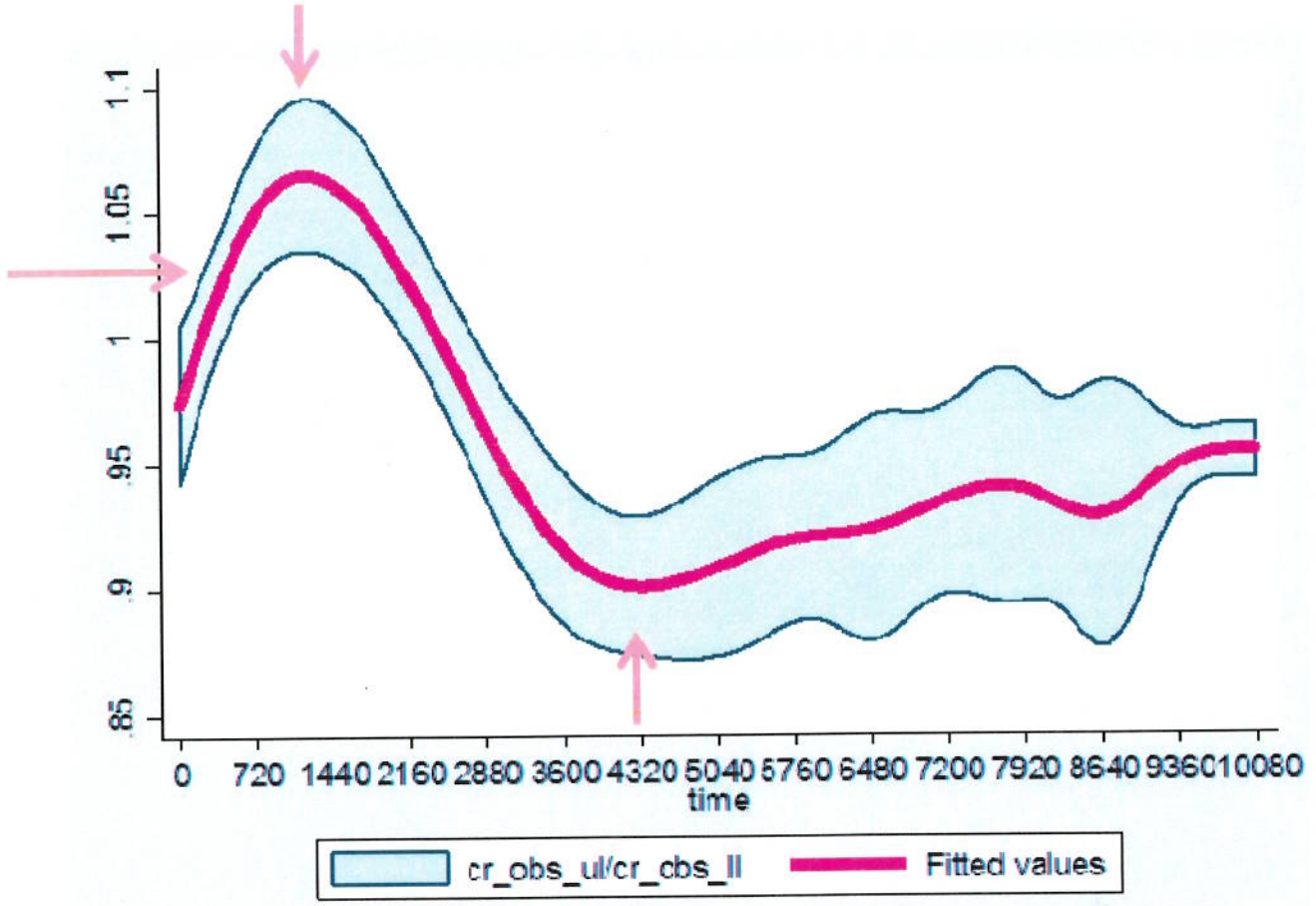
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.85
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2880
3600
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6480
7200
7920
8640
9360
10080
time
cr_obs_ul/cr_obs_ll
Fitted values

Next Steps

- Determine thresholds naïve model
- Build model that includes creatinine production factors
- Compare models
- Compare to nephrologists best guess of when an injury occurred

Future Renal Function Kinetics Calculator

- Focus on EVENTS that harm the kidney and not the STATE of the laboratory results
- Tell us whether the patient is getting better, worse or staying the same
- Assist the clinician with triage and treatment
- Assist the researcher in developing better treatments

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Questions?